

Two series of experiments were then most carefully made, at pressures equal to depths of 250, 500, 750, &c. to 2500 fathoms, the results of which satisfactorily proved that the strongest-made unprotected thermometers were liable to considerable error, and therefore that all previous observations made with such instruments were incorrect.

Experiments were also made in the testing-apparatus with Sir Wm. Thomson's enclosed thermometers, to ascertain the calorific effect produced by the sudden compression of water, in order to find what error, if any, was due to compression in the Miller pattern: an error was proved to exist, but small, amounting to no more than $1^{\circ}\cdot4$ under a pressure of 3 tons to the square inch.

The dredging cruize of the 'Porcupine' afforded an opportunity of comparing the results of the experiments made in the hydraulic testing-apparatus, with actual observation in the ocean, and a most careful series of observations were obtained by Staff-Commander E. K. Calver at depths corresponding to the pressure applied in the testing-apparatus; the result was that, although there was a difference in the curves drawn from the two modes of observation, still the general effect was the same, and the *means* of the two were identical.

From these experiments and observations a scale has been made by which observations made by thermometers of similar construction to those with unprotected bulbs can be corrected and utilized, while it is proposed that by means of observations made with the Miller pattern in the positions and at the same depths at which observations have been made with instruments not now procurable for actual experiment, to form a scale for correcting all observations made with that particular type.

In conclusion, it is suggested that to avoid error from the unsatisfactory working of the steel indices, which, from mechanical difficulties in their construction, cannot always be depended on, two instruments should be sent down for every observation; and although their occasional disagreement of record may raise a doubt, a little experience will enable the observer to detect the faulty indicator, while their agreement will create confidence.

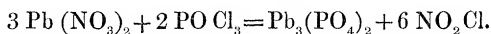
A description of such deep-sea metallic thermometers as have been invented is appended.

IV. "On the Chemical Activity of Nitrates." By EDMUND J. MILLS, D.Sc. Communicated by Prof. A. W. WILLIAMSON.
Received April 21, 1870.

(Abstract.)

In the course of his researches upon nitro-compounds, the author found it extremely desirable to submit the genetic relations of those bodies to a detailed examination; in other words, to trace the modifications undergone

by nitryl as it is transmitted (from the chloride, hydrate, or free radical) through an adequate succession of combinations. One of the first steps in this direction is the preparation of nitrylic chloride, which can be most easily effected, according to a statement in Watts's 'Dictionary of Chemistry' *, by the action of phosphoric oxychloride on plumbic nitrate—



Among other modes of verifying this equation, the examination of the residue left behind when excess of the oxychloride is heated with plumbic nitrate, and then distilled off in a current of dry air, appeared the most simple and obvious. The results were found not to agree with the equation; and after three nitrates had been tried, a law of chemical activity became evident, rendering the reaction worthy of pursuit for its own sake, although, as an available source of nitrylic chloride, it had failed entirely. The nature and mode of establishment of this law constitute the subjects of the author's memoir.

When a nitrate is treated with phosphoric oxychloride, as has just been mentioned, the residue contains phosphoric oxide and a metallic chloride. Within the limits of experimental error, or subject to other satisfactory explanation, the ratio between these two products is constant for each nitrate; and from that ratio a quotient α can be found as follows :—

$$\alpha = \frac{\frac{\text{weight of chlorine}}{\text{Cl}}}{\frac{\text{weight of phosphoric oxide}}{\text{P}_2\text{O}_5}} = \frac{\text{weight of chlorine}}{\text{weight of phosphoric oxide}} \times 4.06.$$

This quotient, which is different for each nitrate, is termed the "co-efficient of chemical activity" of nitrates, and the method of obtaining it is designated the "method of ratios." The data from which α is deduced, namely, certain weights of argentic chloride and magnesian pyrophosphate, are, if singly considered, new with each experiment; they depend on time, rate of heating, the state of division of the nitrate, and other conditions. But, assuming the results to have been brought about under a law of chemical action, the values of α must be independent of those circumstances, by which the primitive numerator and denominator could have been only *pari passu* affected; they are related only to the actual occurrence of the reaction. This property, in a chemical ratio, has not, it is believed, been previously observed.

After describing the means employed for obtaining a current of dry air, the apparatus required for the reaction, and the individual experiments which were severally made, the following Table of results is given, Σ being the symbolic value of a nitrate, and $Q = \frac{\Sigma}{\alpha}$.

* Vol. iv. p. 77.

	α	Σ	Q
{ Thallous nitrate	8·76	265·30	30·29
{ Argentic nitrate	5·48	169·94	31·01
{ Plumbic nitrate	5·17	165·56	32·02
Rubidic nitrate	2·38	147·40	61·93
Cæsic nitrate	2·21	195·01	88·24
{ Potassic nitrate	1·99	101·14	50·82
{ Sodid nitrate	1·70	85·05	50·03
Lithic nitrate	1·61	69·00	42·86

The above list probably contains all the metallic nitrates that can be completely dried, excepting nitrates derived from amines and amides, which, in the present state of our knowledge of the phosphamides, it was evidently advisable to exclude.

In the silver group, the mean value of Q is 31·11; and the following equation may be accepted therefore:—

$$\alpha = \frac{\Sigma}{31\cdot11}.$$

In the potassium group we have likewise

$$\alpha = \frac{\Sigma}{50\cdot42}.$$

Hence, within each set of nitrates, chemical activity is in direct proportion to symbolic value. It is further sufficiently apparent that (excepting rubidic nitrate) α and Σ increase and diminish in the same general order. Within the limits of error, the Q column is an incomplete arithmetical series, the most probable value of whose first term is 6·258, so that

$$Q = m \cdot 6\cdot258,$$

m being integral. Reasons are then adduced for identifying the number 6·25 with Dulong and Petit's constant of specific heat. Moreover, since the product of specific heat and symbolic value is, generally, $n \cdot 6\cdot25$, and m is greater than n , taking $m = xn$ and $s =$ the specific heat of a nitrate, we have

$$Q = xn \cdot 6\cdot25,$$

but

$$\Sigma s = n \cdot 6\cdot25;$$

$$\therefore Q = x \Sigma s,$$

and

$$\alpha = \frac{\Sigma}{Q} = \frac{\Sigma}{x \Sigma s} = \frac{1}{xs},$$

the expression for chemical activity in terms of specific heat. Comparing the coefficients (α, α') for any two nitrates, the following relations are obtained:—

$$\frac{\alpha}{\alpha'} = \frac{m'}{m} \cdot \frac{\Sigma}{\Sigma'} = \frac{x's'}{xs};$$

and it is shown that these formulæ agree sufficiently well with experiment. Where $m = m'$ and $x = x'$, we have the simple expression

$$\frac{\alpha}{\alpha'} = \frac{\Sigma}{\Sigma'} = \frac{s'}{s}.$$

The values of Q are strictly *equivalent* to each other in point of activity. The author believes that α is commensurate with the elective function of chemical attraction, first discovered by Bergman. He terminates the memoir with a reference to some well-known instances of chemical action (such as that of argentic nitrate on a mixture of aqueous potassic chloride, bromide, and iodide), as serving to bestow a presumptive generality on his principal conclusions.

V. "On the relative Duration of the Component Parts of the Radial Sphygmograph Trace in Health." By A. H. GARROD, of St. John's College, Cambridge. Communicated by Dr. GARROD. Received April 23, 1870.

The graphic method of representing the various phenomena occurring in the body during life, which has been so much developed by MM. Marey and Chauveau of Paris, has placed within our reach great facilities for obtaining an accurate knowledge of the relations, in point of time, of mutually dependent physiological events, and the sphygmograph has become, among others, an instrument familiar to most interested in science.

By means of this instrument, a detailed and truthful record can be easily obtained of the modifications in the diameter of any superficial artery, and, as usually constructed, it is intended to be applied to the radial at the wrist.

The traces to be referred to were taken with one of Marey's instruments, as made by Breguet. The recording paper ran its whole length, $4\frac{3}{8}$ inches, in seven seconds, and thus, by counting the number of pulse-beats in each trace, and multiplying the number thus obtained by 8.57143, the rate of the pulse at the time the trace was taken was easily found.

The lever-pen was of thin steel, sharply pointed, and it recorded by scratching on highly-polished paper previously smoked.

It is now generally agreed that in each pulsation of the radial sphygmograph trace, the main rise is the effect of the contracting ventricle sending blood into, and thus filling, the arterial system.

This rise is followed by a continuous fall when the pulse is quick, but when slow, its continuity is interrupted by a slight undulation, convex upwards.

The major fall is followed by a secondary rise, not so considerable as the main one, but more marked than any other, and this secondary rise is evidently due to the closure of the aortic valves preventing further flow of blood heartwards.

The two points therefore, the commencement of the primary and of the secondary rise, may be considered to mark the beginning of the systole of the heart, and the closure of the aortic valve respectively, as far as they influence the artery at the wrist; and the interval between these two events may be called the *first* part of the arterial sphygmograph trace,